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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : D04H 1/54, 13/00, 1/00, D21H 13/14, 15/10

A1

(11) International Publication Number: WO 98/28477

(43) International Publication Date: 2 July 1998 (02.07.98)

(21) International Application Number: PCT/IE97/00087

(22) International Filing Date: 22 December 1997 (22.12.97)

(30) Priority Data:
S960919 20 December 1996 (20.12.96) IE

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(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DE (Utility model), DK, DK (Utility model), EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A NON-WOVEN CLOTH

(57) Abstract

A non-woven cloth, particularly sailcloth, which is substantially non-porous in which the cloth is formed by a matrix of bicomponent fibres and high tenacity additive fibres, the cloth having a weight greater than 90g per m^2. The cloth is formed in a wet-lay process in which a cloth sheet is formed, delivered through an air dryer to fuse the fibres and then immediately calendered at high pressure.

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"A Non-Woven Cloth"

This invention relates to a non-woven cloth.

Woven cloths are widely used, however they have some limitations. They are relatively expensive to produce. Also, while being relatively strong when pulled in a longitudinal or transverse direction, that is in the direction of the warp or the weft they are relatively weak when pulled at an angle, for example 45°C to the warp or weft and will stretch easily in this direction. This presents problems in manufacturing sails for example, and various relatively complex configurations of cloth panels are sewn together in manufacturing sails to minimise this problem as it is important for the sails to be stiff and not stretch easily.

The present invention is directed towards overcoming these problems.

According to the invention there is provided a non-woven cloth material in which the cloth is formed by a matrix of bicomponent fibres. Preferably the weight of the cloth is greater than 90g per m^2 and the cloth is substantially non-porous. Bicomponent fibres essentially comprise a core of plastic material surrounded by an outer sheath also of plastic material, with the outer sheath having a lower melting point then the core. The bicomponent fibres are bonded together in the matrix by fusing the outer sheath's of the bicomponent fibres.

Various different types of bicomponent fibres may be used. For example bicomponent having a core of polypropylene or polyester and having an outer sheath of polyethylene, polypropylene, polyester or nylon. It is envisaged that various other types of plastics material could also be

used. Combinations of two or more different bicomponents may also be used. Ideally the bicomponent fibres have a reasonably high tenacity or modulus of elasticity.

Various additive fibres may be included in the matrix to impart desirable characteristics in the cloth e.g. to increase the stiffness of the cloth. The bicomponent fibres, which constitute the majority, act as a matrix, securing the additive fibres in place.

Conveniently the additives may include high tenacity fibres (i.e. greater than 500 CN/Tex). Examples of these includes Vectran (registered Trade Mark) liquid crystal high modulus fibres, aramid fibres e.g. kevlar (registered Trade Mark), and carbon fibres. Other possible additive fibres include Spectra (Registered Trade Mark) from Allied Signal Corporation, Dynema from DSM, Twaron from AKZO and PBO from Toyobo. Either one or a combination of two or more additive fibres may be used. For example a quantity of additive fibres containing liquid crystal vectran fibres and other aramid fibres in the ratio 1:1 may be used. In addition to high modulus additive fibres, other fibres may also be added. Coloured fibres may add a desired colour. Fusible or meltable fibres may be added to improve sheet strength.

Typically the additive fibres comprise between 5% and 25% of the overall fibres in the matrix.

In another embodiment the invention provides a composite cloth material comprising a support sheet fused with and integrally formed with the bicomponent fibres. The support sheet may comprise a scrim sheet or a plastics film for example.

In another aspect the invention provides a sailcloth formed from a non-woven cloth material in which the cloth is formed by a matrix of bicomponent fibres.

In a further aspect the invention provides a process for producing a cloth material according to the steps:-

forming a wet lay cloth of bicomponent fibres mixed with additive fibres;

drying the wet lay cloth, and

calendering the wet lay cloth.

Preferably the drying is carried out by delivering hot air through the cloth. This can conveniently be carried out in a through air dryer. The air should be hot enough for fusing the outer sheath's of the bicomponent fibres together but not hot enough to reduce the tenacity of the fibres. The calendering should be carried out immediately downstream of the dryer.

Preferably the calendering is carried out by passing the cloth between a pair of calendering rollers and squeezing the cloth between the rollers, applying a desired pressure to the cloth as it passes between the rollers.

In another embodiment the process includes heating the rollers. Ideally, the outer surface temperature of the rollers is maintained at a temperature which is lower than the melting point of the outer sheath of the bicomponent fibres.

It is also possible to use cold rollers, however this will give a more coarse surface finish to the cloth. With

heated rollers a smooth surface finish can be achieved which may be preferable in many applications.

In a further embodiment there is provided a cloth manufacturing process comprising the steps:-

mixing bicomponent fibres and additive fibres with water in a stock tank to form a liquid stock,

discharging the liquid stock from the stock tank,

diluting the liquid stock with water to form a liquid stock with a desired quantity of bicomponent fibres, delivering a layer stock on to the surface of a forming conveyor,

extracting water through the conveyor to form a wet sheet of cloth on the conveyor,

passing the sheet of cloth through a dryer,

heating the sheet of cloth in the dryer to fuse the outer sheaths of the bicomponent fibres together, and

calendering the sheet of cloth downstream the dryer while the cloth is still hot to ensure widespread bonding and strength throughout the sheet.

In another embodiment the process comprises the steps:

forming a pair of wet-lay cloths of bicomponent fibres mixed with additive fibres,

feeding a support sheet between the two wet-lay cloths to form a composite cloth,

drying the composite cloth, and

calendering the composite cloth.

The support sheet may comprise a scrim sheet or a plastics film for example.

In another embodiment instead of calendering the cloth downstream of the dryer, the process includes pressing the wet-lay cloth into a desired three-dimensional shape in a mould.

The invention will be more clearly understood by the following description of some embodiments thereof, given by way of example only, with reference to the accompanying drawings, in which:

Fig 1 is a schematic illustration of a process line for producing a cloth according to the invention;

Fig 2 is a perspective view showing portion of a bicomponent fibre used in the cloth of the invention.

Fig 3 is a schematic illustration of a pair of bicomponent fibres;

Fig 4 is a schematic illustration similar to Fig 3 showing the bicomponent fibres fused together;

Fig 5 is an enlarged illustration of a portion of a cloth according to the invention showing a matrix of bicomponent fibres in the cloth;

Fig 6 is a graph illustrating the percentage extension of the cloth when a stretching force is applied to the cloth in warp, weft and diagonal directions; and

Fig 7 is a graph similar to Fig 6 showing the percentage extension of a woven cloth when pulled in these different directions.

Referring to the drawings, there is illustrated a non-woven cloth material according to the invention indicated generally by the reference numeral 1. The cloth material is formed by a matrix 2 (Fig 5) of bicomponent fibres.

Fig 2 shows a typical bicomponent fibre comprising a core 5 of plastics material surrounded by an outer sheath 6 of plastics material which has a lower melting point than the material used for the core 5.

A process for forming the non-woven cloth will now be described with reference to Fig 1. Bicomponent fibres and any additive fibres are mixed with water in a stock tank 10 to form a liquid stock. Typically at this stage the liquid stock contains about 0 - 2% of fibres. The liquid stock is pumped from the stock tank 10 to a constant level tank 11. A supply of liquid stock at constant pressure is delivered from the constant level tank 11 through a flow meter 12 and supply valve 13 to an inlet 14 of a pump 15. The pump 15 draws water from a reservoir 16 which mixes with the liquid stock diluting the liquid stock to produce a liquid stock containing approximately 0.02% fibres.

A layer of the liquid stock is delivered onto the surface of a forming conveyor 18. The forming conveyor 18 is porous and a vacuum is applied to an underside of the conveyor to draw off excess water for return to the reservoir 16. A sheet of cloth is thus formed on a surface of the conveyor 18. Additional water may be extracted from the cloth sheet as it passes along a second

conveyor 20, again by applying a vacuum to an underside of the conveyor 20.

At this stage optionally the cloth may be cleaned or otherwise treated for example by delivering a cleaning fluid onto the cloth, the cleaning fluid comprising fresh water which may include a bactericide, silicone, dye or other chemical treatment. The cleaning water is supplied from a reservoir tank 22 to a cascading curtain coater 24 mounted above the conveyer 20.

The sheet of cloth is then delivered into a through air dryer 25 in which heated air is delivered through the cloth, heating the fibres such that the outer sheath 6 of the fibres fuse as shown in Fig 4. Fig 3 shows schematically a pair of overlapping bicomponent fibres 4 prior to delivery of the cloth through the dryer 25. Fig 4 shows schematically the same bicomponent fibres 4 downstream of the dryer 25. It will be noted that the material of the sheath 6 has been softened sufficiently in the dryer 25 to fuse the bicomponent fibres 4 together where they meet. Fig 5 shows in more detail the fused joints between the bicomponent fibres, some the cores of which are shown in broken outline. It will be noted that the air delivered through the cloth in the dryer 25 should be hot enough for fusing the outer sheaths 6 of the bicomponent fibres 4 together but not hot enough to reduce the tenacity of the bicomponent fibres 4.

Immediately downstream of the dryer 25 the cloth is delivered between a pair calendering rollers 26, 27 which apply a pressure to the cloth for compacting the matrix of fibres 4 within the cloth. This stage also greatly increases the number of bicomponent bonds and therefore the strength. Calendering also renders the cloth substantially non-porous. The calendering force is

typically greater than 25 tonnes and preferably about 60 tonnes applied over a 1.2 m nip face of the rollers 26, 27.

The weight of the cloth produced is greater than 90g per m^2. Typically sailcloth produced at a weight of about 250 - 290g per m^2 with heavier sailcloth for large yachts increasing to a weight in the order of 1kg per m^2.

Also for sailcloth a relatively high stiffness is required. The desired stiffness in 7oz per sail makers yd^2 cloth in terms of percentage maximum extension at 80lbs would be 0.5 - 1.0% in the longitudinal and transverse directions and 1.5% in the 45° direction.

If a thick or heavy sheet is required, more than one cloth layer can be fed through the dryer 25 and calender at the same time. The bicomponent bonds then weld or fuse all the layers together so that a single homogenous sheet of bonded fibres is formed. If additive fibres have been added for strength or stiffness, they can have differing concentrations in the various layers to optimise properties of appearance and tear resistance.

Preferably the rollers 26, 27 are heated to a temperature close to but below the melting point of the outer sheath 6. This gives a smooth surface finish to the cloth. The cloth is then rolled up on a reel 28.

Fig 6 shows a graph illustrating the percentage extension of a non-woven cloth according to the invention when pulled in a number of different directions. It will be noted that the extension is generally uniform.

FIg 7 shows the percentage extension of a woven cloth material in which it will be noted that the percentage

extension differs depending on whether the cloth is pulled in a longitudinal direction, a transverse direction or at an angle to the warp/weft of the cloth.

It will be appreciated that the cloth formed according to the invention provides a non-woven cloth without the use of resin. Further the strength of the cloth when pulled in different directions is fairly uniform. Various stiffness can be achieved by varying the proportion of additive fibres. The non-woven cloth according to the invention is also less expensive to manufacture than a woven cloth and can be produced at much higher speeds. Also much wider cloths can be produced by the process according to the invention than is possible with woven cloths. A greater range of manufacturing criteria can be readily easily carried out, for example various degrees of thickness of cloth can be readily easily produced.

There is also no de-lamination problem which occurs with "laminated" cloths such as are presently used in sail making. The laminating glue in "laminated" sails can delaminate relatively easily. The bicomponent bonding of this invention means that no glue is used and the welds of the bicomponent bonds are continuous from top to bottom of the finished sheet, thus preventing delamination.

A further advantage of the cloth formed according to the invention is that it is possible to produce an extremely even density and good appearance in the cloth. Other non-woven processes such as carding and spunbonding produce a cloth which is very uneven and is less suitable in many applications such as sail making for example.

It will be appreciated that sailcloth is but one application of the invention. Parachutes, hot air

balloons, tarpaulins, architectural canopies are examples of other uses.

It will be noted also that if desired a composite cloth may be formed comprising a support sheet of a mesh or scrim or a plastics film which may conveniently be sandwiched between two outer sheets of bicomponent fibre material. The scrim would give increased tear resistance to the sheet. A plastics film may be introduced to increase stiffness or porosity. Additional bicomponent sheet layers may also be provided so that there are three or more bicomponent sheets fused with the support sheet to form the composite cloth.

If desired, after forming the bicomponent sheet as it leaves the oven, the sheet may be delivered, while still hot, to a moulding device in which a three dimensional shape may be moulded into the sheet. The moulding could be carried out by positioning the sheet between two mould parts which are brought together under pressure (50 - 200 tonnes force) to consolidate the bicomponent bonds and impart the desired three dimensional shape to the sheet. Essentially the mould replaces the calendar immediately downstream of the dryer. Thus, for example, a loud speaker cone may be formed from the bicomponent fibre sheet. Typically, this material would contain about 10% carbon fibres mixed with the bicomponent fibres.

The invention is not limited to the embodiment hereinbefore described which may be varied in both construction and detail within the scope of the claims.

CLAIMS

1. A sailcloth formed from a non-woven cloth material in which the cloth is formed by a matrix of bicomponent fibres.

2. A non-woven cloth material in which the cloth is formed by a matrix of bicomponent fibres and in which the weight of the cloth is greater than 90 g/m^2.

3. A cloth material as claimed in claim 1 or 2 wherein additive fibres are included in the matrix to impart desired characteristics to the cloth the additive fibres comprising between 5% and 25% of the overall fibres in the matrix.

4. A cloth material as claimed in claim 3 wherein the additive fibres are high tenacity fibres.

5. A cloth material as claimed in any preceding claim wherein a composite cloth is formed comprising a support sheet fused with and integrally formed with the bicomponent fibres.

6. A cloth material as claimed in claim 5, wherein the support sheet comprises a scrim sheet.

7. A cloth material as claimed in claim 5, wherein the support sheet comprises a plastics film.

8. A process for producing a cloth material according to the steps:-

forming a wet lay cloth of bicomponent fibres mixed with additive fibres,

drying the wet lay cloth, and

calendering the wet lay cloth.

9. A process as claimed in claim 8 wherein the drying is carried out by delivering hot air through the cloth in a through air dryer, the air being hot enough for fusing the outer sheaths of the bicomponent fibres together but not hot enough to reduce the tenacity of the fibres.

10. A process as claimed in claim 8 or 9 wherein the calendering is carried out immediately downstream of the dryer with the cloth still hot by passing the cloth between a pair of calendering rollers and squeezing the cloth between the rollers, applying a desired pressure to the cloth as it passes between the rollers.

11. A process as claimed in claim 10 wherein the process includes heating the rollers.

12. A process as claimed in claim 11 wherein the outer surface temperature of the rollers is maintained at a temperature which is lower than the melting point of the outer sheath of the bicomponent fibres.

13. A process as claimed in any of claims 8 to 12 comprising the steps:-

mixing bicomponent fibres and additive fibres with water in a stock tank to form a liquid stock,

discharging the liquid stock from the stock tank,

diluting the liquid stock with water to form a liquid stock with a desired quantity of bicomponent fibres, delivering a layer stock on to the surface of a forming conveyor,

extracting water through the conveyor to form a wet sheet of cloth on the conveyor,

passing the sheet of cloth through a dryer,

heating the sheet of cloth in the dryer to fuse the outer sheaths of the bicomponent fibres together, and

calendering the sheet of cloth downstream the dryer while the cloth is still hot.

14. A process as claimed in any of claims 8 to 13 comprising the steps:-

forming a pair of wet lay cloths of bicomponent fibres mixed with additive fibres;

feeding a support sheet between the two wet lay cloths to form a composite cloth;

drying the composite cloth; and

calendering the composite cloth.

15. A process as claimed in claim 13 or 14 wherein the support sheet comprises a scrim sheet.

16. A process as claimed in claim 13 or 14 wherein the support sheet comprises a plastics film.

17. A process for producing a non-woven cloth material product according to the steps:-

forming a wet lay cloth of bicomponent fibres mixed with additive fibres;

drying the wet lay cloth and while still hot, pressing the wet lay cloth into a desired three dimensional shape in a mould.

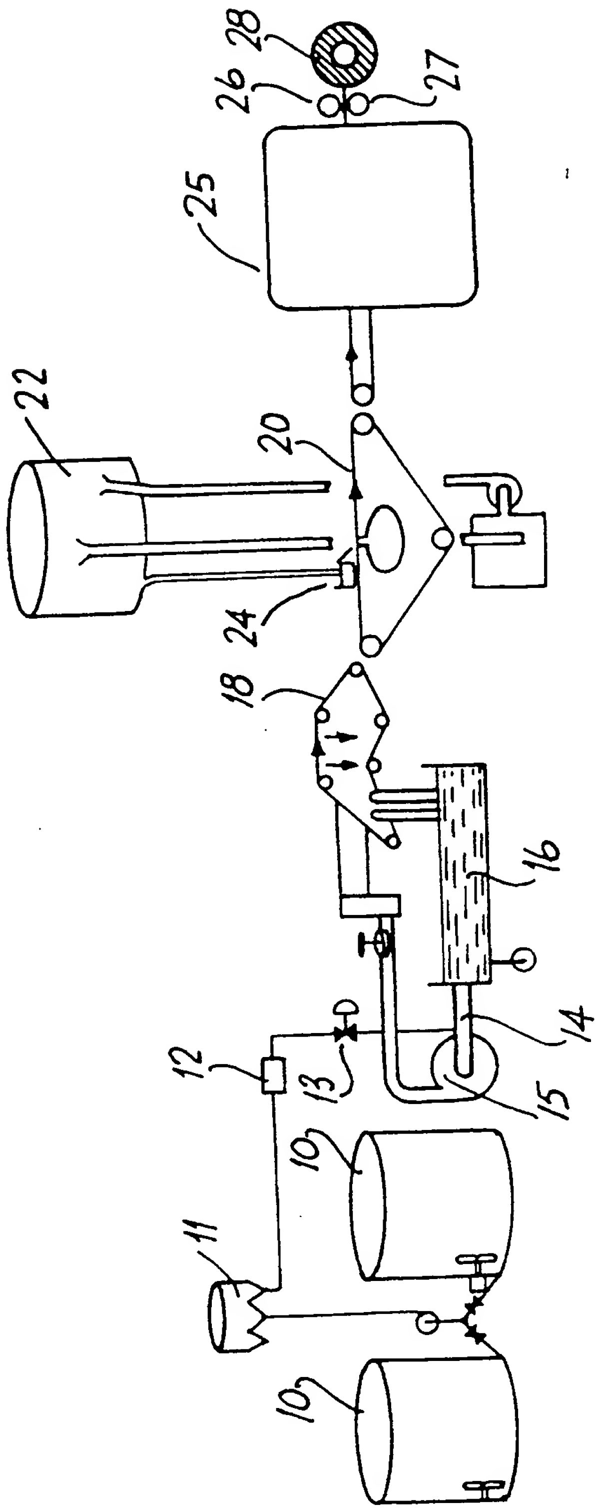


Fig.1

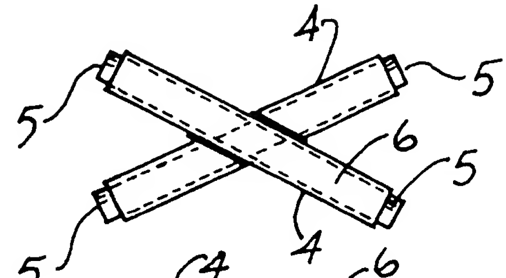


Fig.3

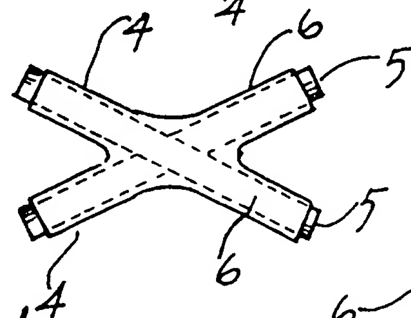


Fig.4

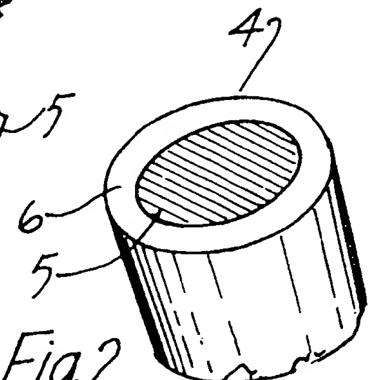


Fig.2

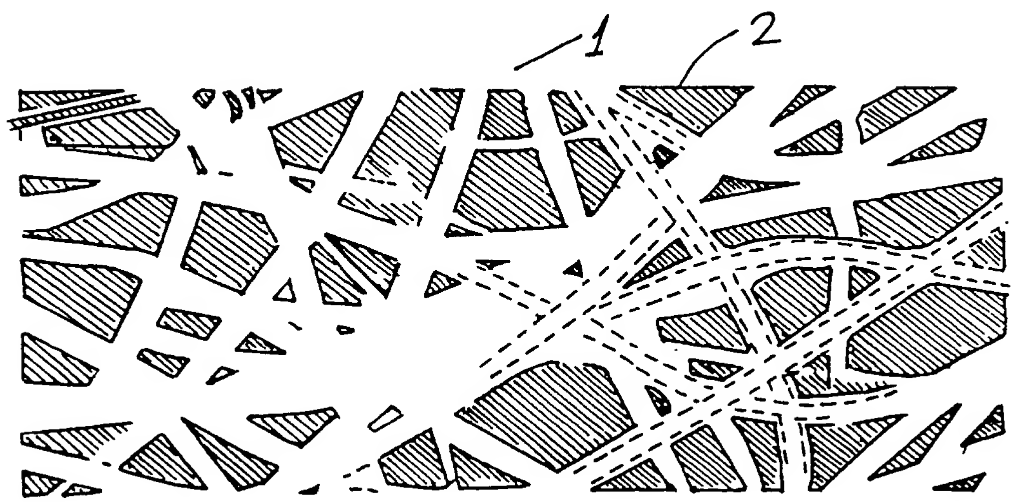
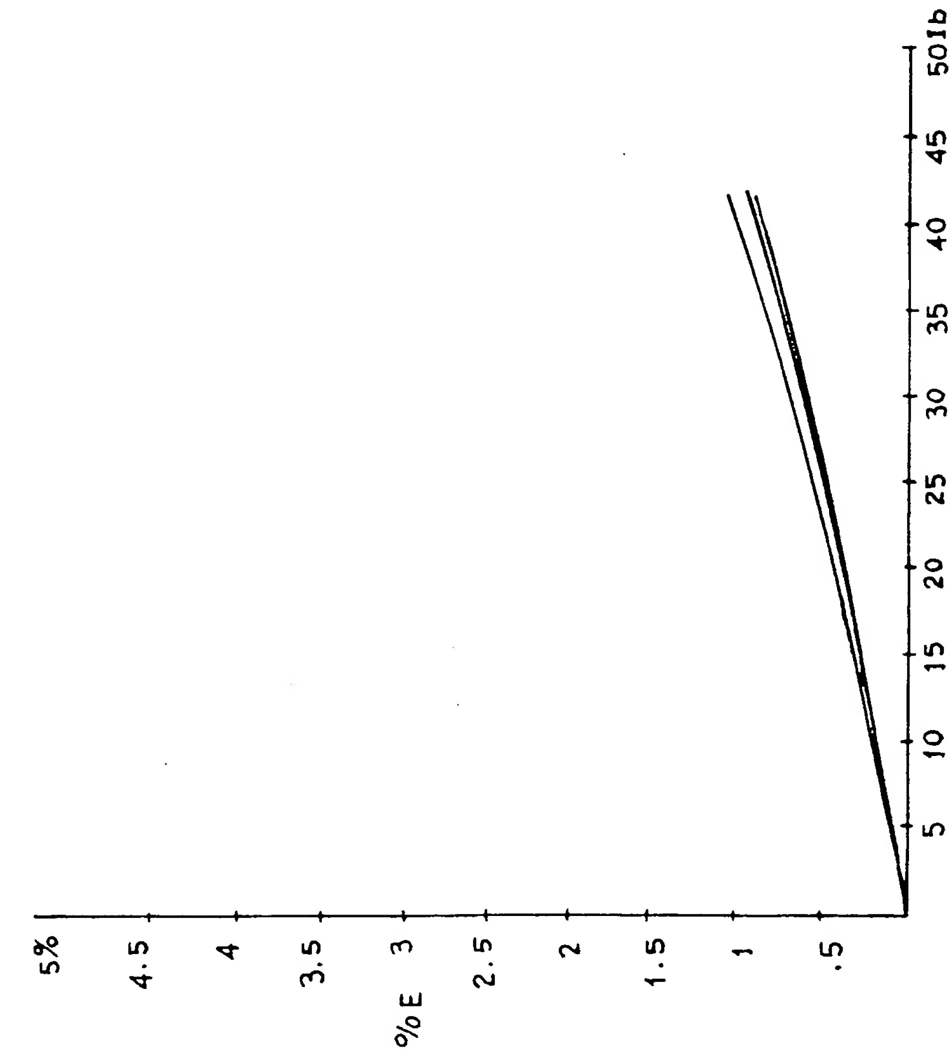


Fig.5

Fig.6



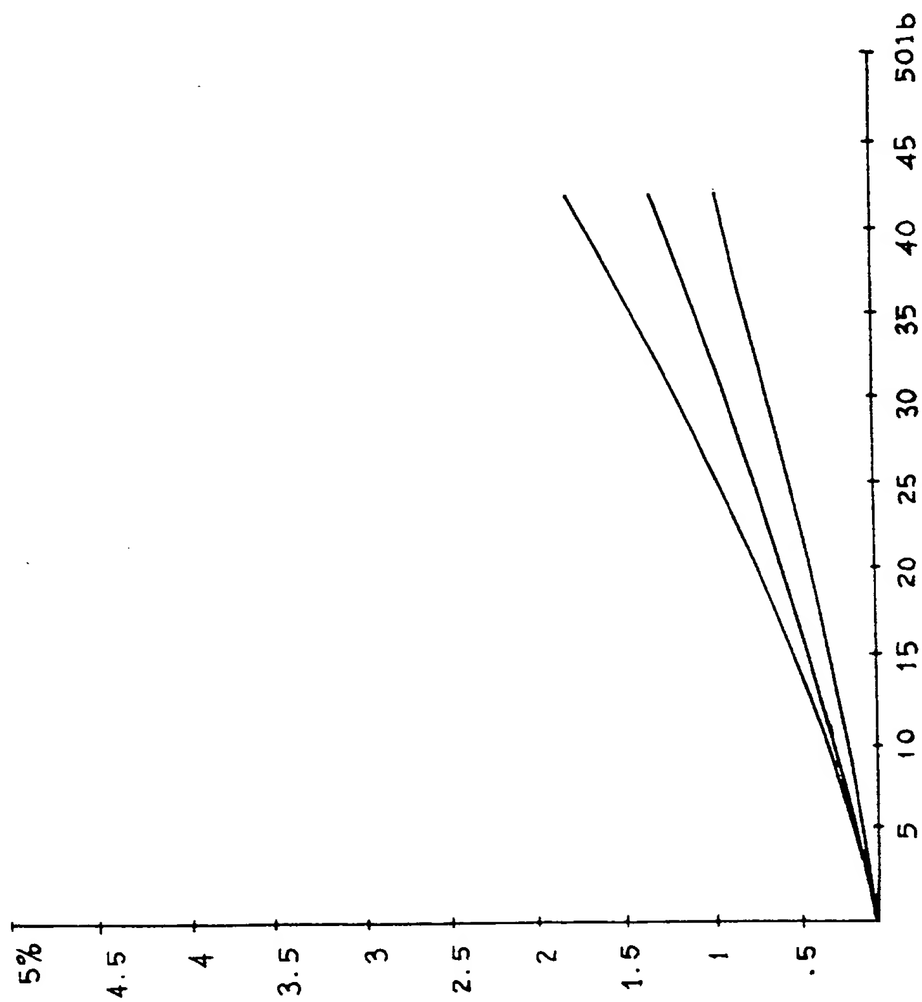


Fig.7